

# BEST AVAILABLE COPY

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

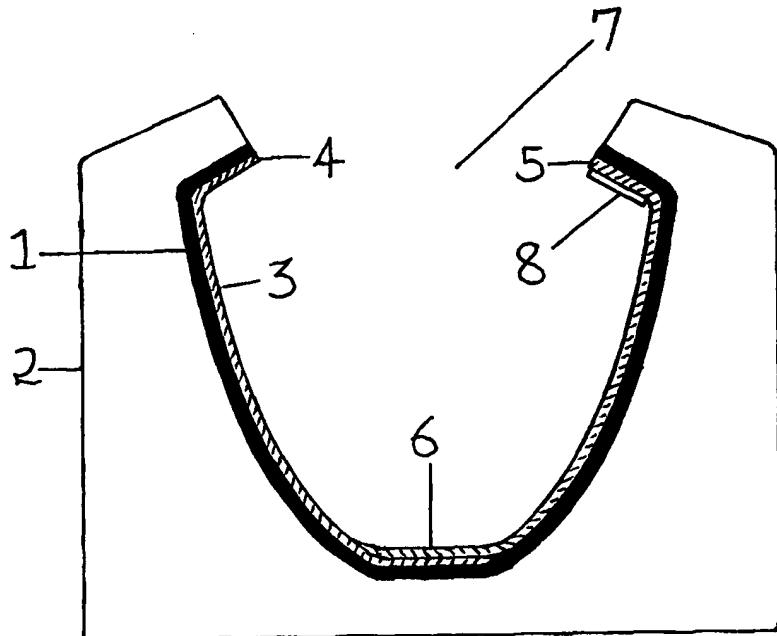
(51) International Patent Classification 6 : B29C 70/30, 33/26 // B29L 23:00	A1	(11) International Publication Number: <b>WO 99/67079</b> (43) International Publication Date: 29 December 1999 (29.12.99)
---	----	---

(21) International Application Number: PCT/CA98/01029 (22) International Filing Date: 6 November 1998 (06.11.98)  (30) Priority Data: 2,237,736 22 June 1998 (22.06.98) CA  (71)(72) Applicant and Inventor: BEADON, Cole, H., C. [GB/CA]; 25 Margaret Street, Alton, Ontario L0N 1A0 (CA).	(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
	Published <i>With international search report.</i>

(54) Title: A PROCESS FOR MANUFACTURING FIBRE REINFORCED PLASTIC MASTS, SPARS OR COLUMNS

(57) Abstract

This is a process for laminating spars, masts or columns using fibre reinforced plastics such as carbon fibre/epoxy, using a concave or "U" shaped female mould (2). After curing, the "U" shaped section (3) is removed from the mould and clamped so that the flanges meet or overlap and can be bonded and/or fastened together to form a closed section with the finished surface on the outside.



**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Larvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon	KR	Republic of Korea	PL	Poland		
CN	China	KZ	Kazakhstan	PT	Portugal		
CU	Cuba	LC	Saint Lucia	RO	Romania		
CZ	Czech Republic	LI	Liechtenstein	RU	Russian Federation		
DE	Germany	LK	Sri Lanka	SD	Sudan		
DK	Denmark	LR	Liberia	SE	Sweden		
EE	Estonia			SG	Singapore		

1.

## A PROCESS FOR MANUFACTURING FIBRE REINFORCED PLASTIC MASTS, SPARS OR COLUMNS

### SPECIFIC

This process relates to the production of light, high strength columns, masts or spars such as but not limited to those used in the sailboat industry, using fibre reinforced plastics such as carbon, Kevlar and glass fibres, impregnated with a bonding resin such as epoxy or polyester.

In general, fibre reinforced masts or spars such as those used in the sailboat industry are wound or moulded around a male mould or mandrel and require finishing on the outside which is labour intensive and therefore expensive. Alternatively they are hand laid up as two or more separate parts using female moulds and later bonded longitudinally to form the closed section, a time consuming process that requires careful control to produce reliable bonded joints. In addition, both methods usually employ vacuum bagging and heat curing in large ovens or autoclaves further adding to the cost of production.

My single concave or "U" shaped female mould method overcomes many of these problems by enabling the part to be moulded by the hand lay-up method using cold cure resins and makes it easy to vary the thickness, orientation and composition of the moulding without affecting the outside dimensions of the finished part.

The cross-section of the concave female mould required that will ultimately produce a closed finished section of the desired shape can be easily pre-determined by calculation, trial and error, or more usually a combination of the two.

The single join required to produce the closed section is also relatively easy to effect and can be done in a number of different ways, some of which are illustrated here. In addition, before the cured part is clamped closed and bonded, inserts and backing plates can be bonded or fastened to the inside of the section to absorb localized loads that might be caused by fittings and fastenings such as spreaders, tangs, tracks or sheaves in the case of sailboat masts. Additional pieces such as conduit for wiring can also be added at this stage.

Furthermore, if a coloured gel-coating is used against the mould surface, the part will not require painting and in the example illustrated will need only a small amount of finishing work along one edge of the bonded joint. Alternatively, a sail track or similar, that is to be fastened over the joint can be so shaped as to hide the unfinished edge further reducing finishing time.

Yet another advantage of this method, is that the clamping together of the "U" section pre-stresses the walls thereby increasing their resistance to buckling.

### THE DRAWINGS

In the drawings, Fig. 1 shows the cross section of a female mould for a typical sailboat mast in which 1, is the mould, ( typically glass reinforced plastic ) and 2, is a plywood brace/stand which allows the mould to be turned on its side to facilitate application. The part 3, with turned in flanges 4 & 5, and a material overlap 6, is applied to the mould through the opening 7. After partial or complete curing, an aluminum or similar strip 8, is bonded to the underside of the right flange 5, which is lower than the left flange 4, by an amount equal to the intended thickness of the part.

Fig. 2 shows the cured part 3, removed from the mould with the flanges clamped together to form a closed section. A bonding agent such as epoxy, 9, has been applied between the flanges, and an aluminum or similar sail track 10, has been fastened 11, with suitable fasteners such as pop-rivets or self-tapping or machine screws, through the flanges to the aluminum strip 8, on the inside, pulling the joint closed and creating both a chemical and a mechanical bond. In this example, the double thickness created by the overlap 6 on the leading edge, is balanced by the double thickness of the bonded flanges on the trailing edge to create added stiffness in the fore and aft axis. Added stiffness in the athwartship axis may also be created during the moulding stage by introducing an overlap on the sides or by adding a narrow layer or layers of uni-directional fibres in that area.

4.

Fig. 3, is an example of a simple clamp that can be made from plywood and 2"x 4" lumber and used to clamp the cured "U" shaped part into the required closed section. It consists of a fixed base and side 1, and a pivoting side 2, which pivots on the bolt & nut 3 and is opened and closed by means of a threaded screw 4, turning in a metal tubing 5. A series of the clamps are arranged at equal intervals along the length of the cured part and are held together longitudinally by the 2"x4" lumber 6, which comprises the base and the jaws. A bonding agent is applied to the flanges and the cured part 7, is clamped shut evenly along its length until the flanges 8, are fully overlapped at which point the exterior track can be positioned and fastened.

Fig. 4 shows an alternative method of bonding, whereby the flanges 1, are inserted and clamped into a pre-formed extrusion 2, with a bonding agent such as epoxy 3, and then through fastened 4, with suitable fasteners such as a pop-rivets or self-tapping or machine screws. An added advantage of this method is that the edges of the flanges require no further finishing.

Fig. 5 shows a method of bonding when no exterior attachment is required. Layers 1, of the same or similar material as the part are applied across the flanges 2, and after curing are rounded off at the edges 3, to provide a smooth finish.

**CLAIMS**

The embodiments of the process in which an exclusive property or privilege is claimed are as follows:

1. A process for manufacturing fibre reinforced plastic masts, spars or columns whereby the part is first moulded in a concave female mould as an open or "U" shaped section, using conventional hand lay-up techniques and cold cure resins, and after curing is clamped, bonded and/or fastened into a closed section of the required shape.
2. A process as defined in claim 1, where the fibres and/or resins are applied using automated machinery.
3. A process as defined in claims 1 and 2, whereby a resin, or fibres pre-impregnated with a resin, that requires heat curing is used.

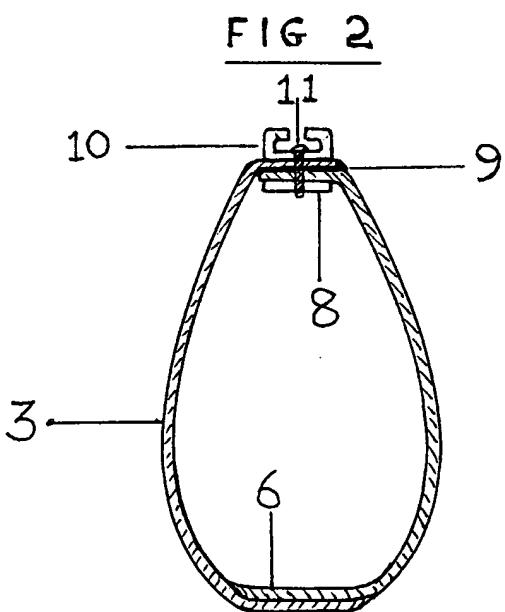
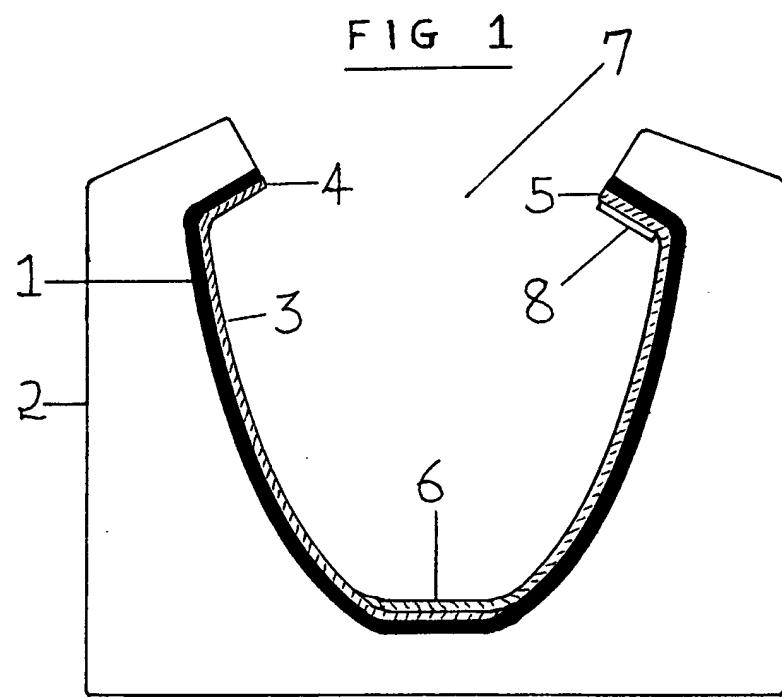


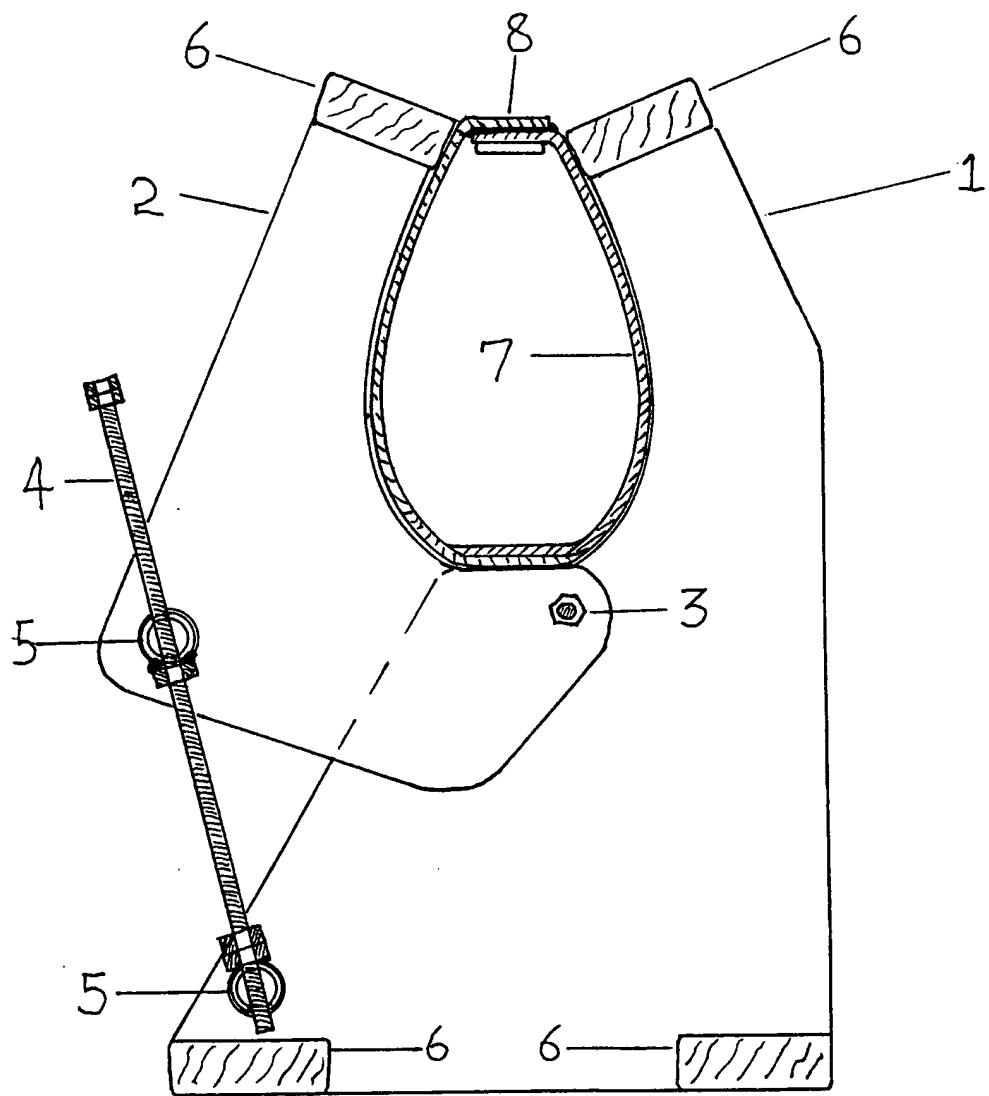
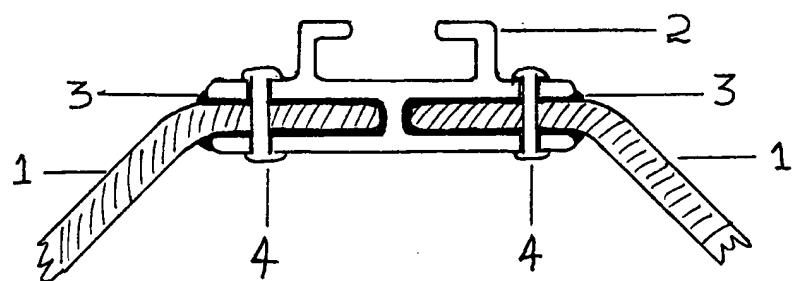
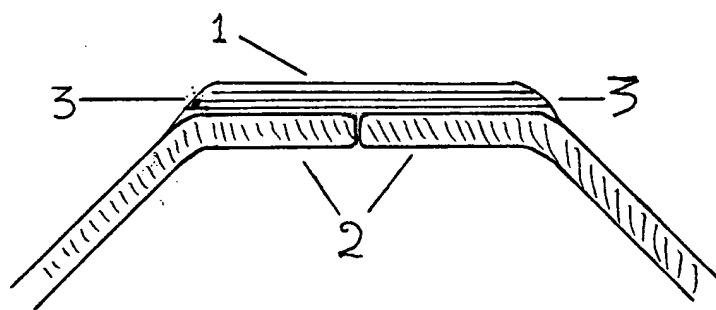
FIG 3

FIG 4FIG 5

# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/CA 98/01029

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 6 B29C70/30 B29C33/26 //B29L23:00

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 396 269 A (HOWLETT IAN C) 7 November 1990 see the whole document ----	1-3
A	FR 2 730 665 A (BIDAULT SIRE PIERRE OLIVIER) 23 August 1996 see claims; figures -----	1-3

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

\* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

10 February 1999

Date of mailing of the international search report

19/02/1999

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Van Wallene, A

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International Application No

PCT/CA 98/01029

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP 0396269	A 07-11-1990	GB	2230225 A	17-10-1990
		AU	628512 B	17-09-1992
		AU	5317190 A	18-10-1990
		DE	69004480 D	16-12-1993
		DE	69004480 T	03-03-1994
		US	5085820 A	04-02-1992
FR 2730665	A 23-08-1996	NONE		